Worcester Polytechnic Institute
Gordon Library and Fuller Laboratory

B.N. Tripathi

Senior Vice President

CES/Way

Worcester Polytechnic Institute
Gordon Library

- College Library
- 63,700 sq.ft., 6 floors
- Masonry Construction (1958)
- Open 8 am to midnight
- Internal Loads/Equipment
  - Lighting
  - People

Worcester Polytechnic Institute
Fuller Laboratory

- Computer Science Laboratory
- 65,000 sq.ft., 4 floors
- Masonry Construction (1985)
- Open 6 am to midnight
- Internal Loads/Equipment
  - Lights
  - People
  - Computer Center

Worcester Polytechnic Institute
HVAC Equipment

Gordon Library

- 250 ton Trane centrifugal chiller
  - R-12 refrigerant, 0.85 kW/ton
- Multi-zone air handling units
  - 2 per floor, 20 zones per AHU
- 1970s pneumatic control system
  - Buck Rogers technology

Fuller Laboratory

- Two 200 ton Trane rooftop packaged DX chillers
  - run year round
- 3 large air handling units
  - variable air volume
- 1985 EMS system

Worcester Polytechnic Institute
Utility Use

- Entire Campus
  - 29 buildings, 1.2 million square feet, 1500 students
  - electricity for cooling, lighting, etc., 15.7 million kW/year
  - oil use for heating, 550,000 gallons/year
  - total energy use of 3.1 MW or $1.4 million/year
- Gordon Library
  - summer peak due to cooling energy use
- Fuller Laboratory
  - little seasonal variation due to cooling for computer labs

Worcester Polytechnic Institute
Project Scenario

Gordon Library

- CFCs in chiller
- Oversized chiller
- Dampers on AHUs only either open or closed
- Indoor air quality issues
- Year-round heating and cooling

Fuller Laboratory

- Freeze ups during year-round chiller operation
- High energy costs
- High maintenance costs

- Part of a campus-wide energy retrofit project

Worcester Polytechnic Institute
Cooling Plant Improvements

- **Gordon Library**
  - New Carrier screw chiller, downsized to 170 tons
  - 0.62 kW/ton (down from 0.85 kW/ton)
  - R-22, HCFC refrigerant, with oxygen depletion sensors
- **Fuller Laboratory**
  - Added 200 ton cooling tower and heat exchanger
    - > free winter cooling during 5 months of the year
    - > eliminates chiller freeze ups
    - > cooling tower loop separated from chilled water loop by the heat exchanger

Worcester Polytechnic Institute
System Improvements

- **Gordon Library**
  - New variable system drive chilled water pumps under EMS control
  - Air handling units given new direct digital controls
    - > outside air dampers & thermostats replaced
    - > new electric actuators hooked to CO_2 sensors
- **Fuller Laboratory**
  - Variable speed drives controlled by EMS, inlet vanes locked open

Worcester Polytechnic Institute
Lighting Improvements

- Initially both buildings had T-12 fluorescents and incandescent lamps
- Comprehensive lighting retrofit
  - T-8 lighting
  - compact fluroescents
  - new low-energy exit signs
- Gordon Library reduced load by 37 kW
- Fuller Laboratory reduced load by 32 kW

Worcester Polytechnic Institute
Financing Structure

- Tax exempt bond at 4.5% interest
- CES/Way hired as energy service company (ESCo)
  - campus-wide project for $2.2 million
  - utility incentives/rebates of $525,000
  - annual energy savings of $275,000
  - 6.1 year simple payback period

Worcester Polytechnic Institute
Gordon Library and Fuller Laboratory Finances

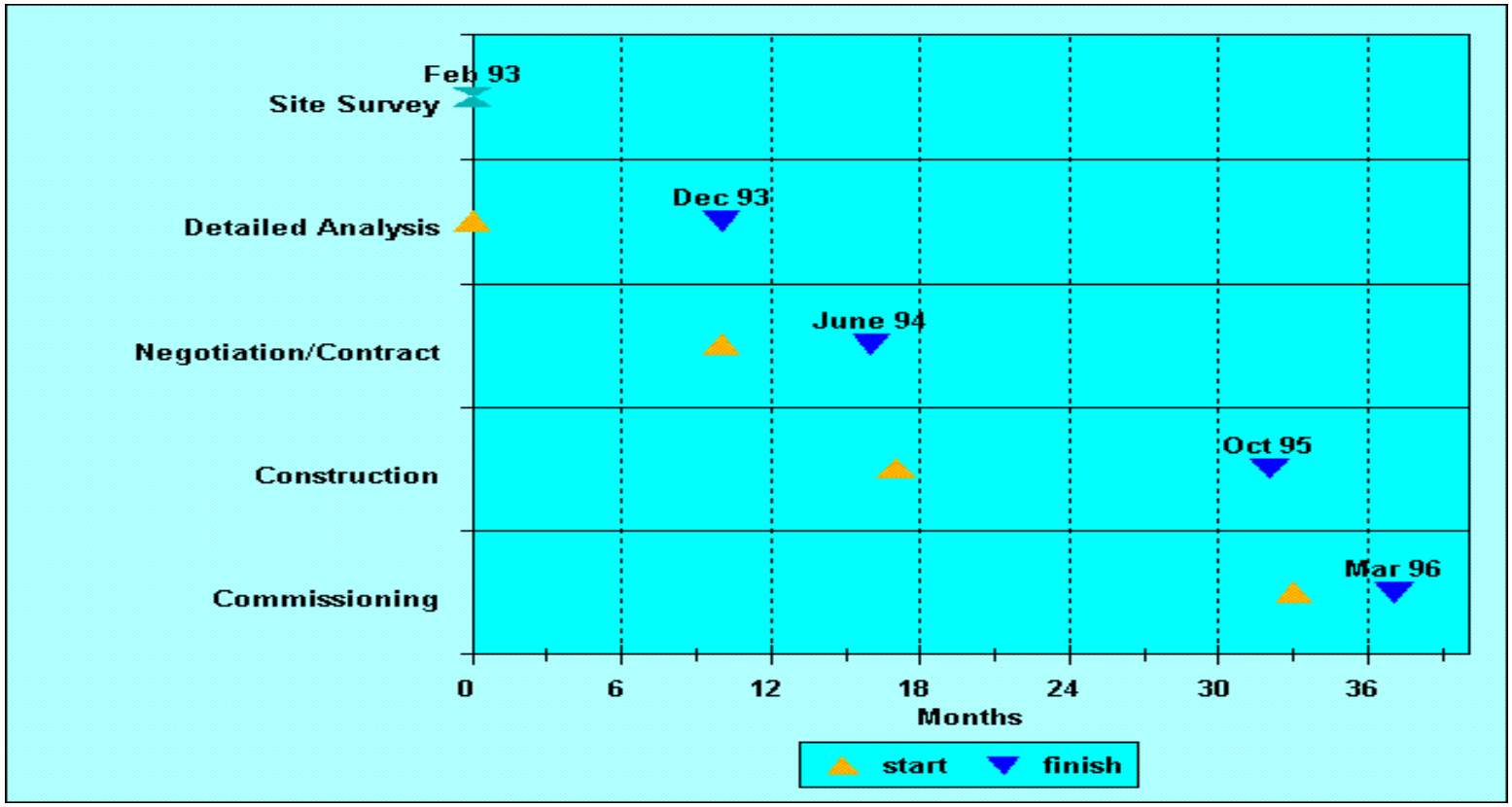
Integrated Options	Cost ($)	Utility Incentive ($)	Annual Energy Savings($)	Payback Period (years)
Gordon Library				
New Chiller	110,240	4,250	6,429	16.5
AHU Controls	6,877	4,428	560	4.4
EMS plus VSD pumps	31,492	1,270	235	128.6
Lighting Retrofits	104,913	28,050	24,717	3.1
Fuller Laboratory				
CoolingTower/HeatEx	221,387	141,284	21,074	3.8
VSD	43,562	5,400	4,417	8.6
Lighting Retrofits	54,711	15,885	13,997	2.8
Total	$573,182	$200,567	$71,429	5.2

- Chiller and EMS financed by other retrofit options

Worcester Polytechnic Institute
Project Metering

- No individual building meters to establish historical energy use
- Metering crucial to setting baselines & determining savings and hence payments to ESCo
- Massachusetts Performance Engineering Program
  - equipment metered for 2 weeks to measure performance
  - energy use metered for months before retrofit and for 2 years after retrofit
  - continual monitoring to reduce consumption
- Exceeded Performance Engineering Projections
  - saved more energy than expected

Worcester Polytechnic Institute
Project Timeline



Worcester Polytechnic Institute
Project Results

- **Gordon Library**
  - CFC & oversizing issues addressed by chiller replacement
  - Air quality and comfort improved with AHU controls
  - Lighting improvements reduce building loads
- **Fuller Laboratory**
  - Freeze up of chillers in winter avoided
  - “Free” winter cooling with cooling tower/heat exchanger
  - Lighting improvements reduce building loads

Worcester Polytechnic Institute
Benefits of this Integrated Retrofit

- CFC issues addressed & environmental quality improved
- Building loads reduced
- Building comfort and indoor air quality improved
- New high efficiency chiller installed
- Proper equipment commissioning and on-going monitoring and service
- Measures with lower paybacks finance chiller replacement
- Full advantage taken of utility rebate and incentive programs